Domain structure and grain orientation in PLZT ceramics using electron backscatter diffraction and piezoresponse force microscopy

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The unique properties of relaxor ferroelectrics have raised interest in understanding the micro- and nanodomain structures and their evolution during polarization reversal. The advantages of relaxor ceramic of lanthanum doped lead zirconate-titanate (PLZT) are high optical transparency and electro-optical coefficients. PLZT was successfully used in segment displays, optical closures, coherent modulators, color filters, image storage devices, etc. [1]. The functional properties of ferroelectric ceramic materials are strongly influenced by their nanostructure and crystallographic orientation [2].

We will present the results of crystallographic mapping by electron backscatter diffraction [3] and domain structure visualization by piezoresponse force microscopy [4] in PLZT ceramics.

The studied $Pb_{1-x}La_x(Zn_{0.65}Ti_{0.35})_{1-x/4}O_3$ ceramics (PLZT 8/65/35) were sintered by the hot pressing method at the Ceramics Department of Jozef Stefan Institute, Ljubljana, Slovenia. Samples were polished to the optical quality with a gradual decrease of diamond abrasive down to 0.25 μm and mechanochemical polishing by colloidal silica. Thermal depolarization was carried out during cooling from 200°C to room temperature with cooling rate 5°C/min without electric field. The domain visualization by piezoresponse force microscopy (PFM) by means of scanning probe microscope NTEGRA Aura (NT-MDT SI, Russia) using silicon tips with a diamond-like conductive coating. The grain crystallographic orientations were obtained by electron backscatter diffraction (EBSD) by means of the scanning electron microscope Auriga CrossBeam workstation (Carl Zeiss NTS, Germany). The marking of the investigated area by nano-hardness tester NanoScan-4D (FSBI TISNCM, Russia) allowed to study the same region of the sample surface by both methods.

The analysis of the obtained grain orientation mapping allowed us to reveal the significant texture of the studied ceramics. Moreover, it was demonstrated that the domain patterns depend essentially on the grain orientation. Statistical analysis of the geometrical parameters of domain patterns for the grains with the same orientation has been used for detail characterization of the domain structure.

The realized method will be used for investigation of influence of the grain orientation on the domain structure appeared in ceramics after thermal depolarization, application of uniform electric field and local switching by conductive tip.

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